

simpson

OPERATOR'S MANUAL

**MODEL 467-2T
TRUE RMS
DIGITAL MULTIMETER
WITH DIGALOG™ DISPLAY**

WARNING

**READ AND UNDERSTAND THIS MANUAL
BEFORE USING THE INSTRUMENT.**

**Failure to understand and comply with the
WARNINGS and operating instructions can
result in serious or fatal injuries and/or prop-
erty damage.**

DIGITAL INSTRUMENT Warranty

SIMPSON ELECTRIC COMPANY warrants each digital instrument manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any digital instrument which shall within one (1) year after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any digital instrument which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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OPERATOR'S MANUAL

MODEL 467-2T TRUE RMS DIGITAL MULTIMETER WITH DIGALOG™ DISPLAY

NOTE: This Operator's Manual contains information essential to the operation of this Instrument. Therefore, it should be kept with the Instrument for reference as required.



924 U

This symbol on the nameplate means the product is listed by Underwriters Laboratories Inc. and complies with UL 1244, Standard for Safety—Electrical and Electronic Measuring and Testing Equipment.

123.01

Printed in U.S.A.

Edition: 4th

Effective Date: 0390

Part No. 6-113540

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SAFETY SYMBOLS



This marking adjacent to another marking or a terminal or Operating device indicates that the Operator must refer to an explanation in the Operating Instructions to avoid damage to the equipment and/or to avoid personal injury.



This WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly performed or adhered to, could result in personal injury.



This CAUTION sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly adhered to could result in damage to or destruction of part or all of the Instrument.



MAXIMUM RATED CIRCUIT-TO-GROUND VOLTAGE: This marking limits the voltage, with respect to earth (power line) ground, that may be applied to any terminal of the Instrument to 1000 V PEAK (DC + PEAK AC).



A terminal or circuit to which, or from which, a direct voltage or current may be applied or supplied.



A terminal or circuit to which, or from which, an alternating voltage or current may be applied or supplied.

WARNING

This Instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe any instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

Multi-function instruments such as the 467 Series 2T are intended as general purpose measuring instruments for use in relatively low power 120/240 V AC or dry battery operated circuits such as found in consumer appliances, home entertainment equipment or general laboratory applications. Some high power circuits, however, are within its measurement range and present an arcing/explosion hazard in the event of an unanticipated circuit behavior, a defective measuring instrument, or of an operator error if the operator has not recognized the hazard and observed appropriate personal protective measures. Such high power circuit that would be within the measuring range of this Instrument would be found in commercial or industrial equipment operating from AC and DC supply circuits above 240 V, storage battery banks or circuits containing large capacitors. Measurements in such circuits should only be performed by personnel trained to recognize the hazards and using appropriate safety measures. The Safety Precautions in Section IV are intended to alert the operator to the more commonly encountered hazards and protective measures to avoid them. The dangers in high power circuits are serious. Do not take safety precautions lightly.

NOTE: Any circuit containing voltages exceeding 30 V AC or 60 V DC should be considered to be a possible shock hazard, and contact with the circuit should be avoided while the circuit is energized.



**Figure 1-1. Model 467-2T
Digital Multimeter**

SECTION I

INTRODUCTION

1.1 GENERAL

1.1.1 The 467 Series 2T Digital Multimeter (hereafter referred to as the 467 or the Instrument) offers the best of both worlds, a unique combination of digital and analog liquid crystal display (LCD) used to analyze both steady and pulsating signals, positive peak-holding capability, and fast pulse detection and indication. In addition to the traditional voltage, current and resistance measurements of a $3\frac{1}{2}$ digit multimeter, this versatile Instrument can actually replace the oscilloscope and the logic probe used in many applications.

1.1.2 In the differential peak mode, the 467 can make percent modulation and signal tracing measurements. In the pulse detection mode, the Instrument offers visual and/or audible indication of the presence of pulses and logic levels. The LCD analog bar graph display provides a rapid indication of either voltage or current signal levels, offering the advantages of nulling and peaking from an analog meter.

1.1.3 Other standard features of the 467 include: true rms measuring capability, basic 0.1% DC voltage accuracy, continuity detection with both visual and audible indications, high voltage transient protection and double-fuse protection in the current ranges.

1.1.4 This Instrument also has two unique features; the ability to measure dB (with both 600 Ω /1 mW and 900 Ω /1 mW references), and has a self-contained 1004 Hz, 0 dBm sine wave oscillator, both of which combine to give added convenience to the telecommunications industry.

Introduction

1.1.5 The 467 is designed to operate continuously for 100 hours in the DC voltage mode using a single 9 V alkaline “transistor” battery (NEDA 1604A). A carbon-zinc type battery (NEDA 1604) may be substituted, with a reduction in operation to about 50 hours. A “B” symbol on the display is used to automatically indicate a low battery voltage, and to signify a remaining battery life of approximately 8 hours.

1.1.6 The 467 display consists of a single liquid crystal display that includes the following: numerical display, analog bar graph, and two triangular symbols for pulse and continuity indications. The numerical display has 3½ digit, 7-segment, high contrast numerals that are 0.4 inches high and are in a single plane for distant and wide-angle viewing. The analog bar graph is constructed with 20 segments, absolute value reading and left-hand zero.

1.2 ITEMS AND ACCESSORIES

1.2.1 All items and accessories required for the operation of the 467 are furnished with the Instrument and listed in Table 1-1. Available replacement parts are listed in Table 8-1.

**Table 1-1. Items and Accessories
Furnished With This Instrument**

Quantity	Description	Number
1	Operator's Manual	6-113540
1	Battery, 9 V Alkaline (NEDA 1604A)	5-114907*
1	Test Lead Set	00043
1	Oscillator Cable	02061

**Available through local retail stores.*

1.3 SAFETY CONSIDERATIONS

1.3.1 This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and servicing conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and is defined at the front of this manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of this Instrument, these instructions must be adhered to.

1.4 TECHNICAL DATA

1.4.1 Table 1-2 lists the technical data for the 467 Digital Multimeter.

TABLE 1-2. TECHNICAL DATA

The following electrical specifications are valid for an operating temperature of $+18^{\circ}$ to $+28^{\circ}\text{C}$ at relative humidity up to 90% unless otherwise noted.

1. DC VOLTS

Range	Maximum Indication	Input Resistance	Overload Protected To
200 mV	$\pm 199.9 \text{ mV}$	10 M Ω All Ranges	1000 V (DC + peak AC) All Ranges
2 V	$\pm 1.999 \text{ V}$		
20 V	$\pm 19.99 \text{ V}$		
200 V	$\pm 199.9 \text{ V}$		
1000 V	$\pm 1000 \text{ V}$ (Max. Input)		

Accuracy: $\pm (0.1\% \text{ of input} + 1 \text{ count})$

Sensitivity: 100 μV on 200 mV range

Full Range

Step Response: 1 second

Introduction

Normal Mode

Rejection: 50 dB minimum @ 50/60 Hz

Common Mode

Rejection: 120 dB minimum @ 50/60 Hz and DC with 1 k Ω unbalance

2. AC VOLTAGE (AC coupled trms)

ACCURACY

Range	Maximum Indication	20 Hz to 40 Hz	40 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 20 kHz	20 kHz to 100 kHz
200 mV	199.9 mV	±(1.5% of Input + 5 Counts)	±(0.5% of Input + 5 Counts)	±(5.0% of Input + 5 Counts)	± 1 dB *	± 3 dB *
2 V	1.999 V					
20 V	19.99 V					
200 V	199.9 V					
750 V	750 V (Max. Input)		To 400 Hz only	NOT SPECIFIED		

*Typical extended frequency response

Crest Factor

(at full scale): 3:1

Full Range Step

Response (to
rated accuracy): 3 seconds

Input Impedance: 10 M Ω , <100 pF all ranges

Overload

Protected to: 1000 V (DC + peak AC) or 750 V rms, not to exceed the volt-Hertz product of 10^7 .

3. DECIBELS (AC coupled trms, ACV only)

Reference: 0 dBm = 1 mW into 600 Ω or 1 mW into 900 Ω , switch selectable.

Sensitivity: 0.1 dB, all ranges.

Input Impedance: 10 M Ω in parallel with less than 100 pF.

Accuracy: ± 0.5 dB, upper 50% of each range.
 ± 1.0 dB, lower 50% of each range.

Introduction

Overload Protected to: 1000 V (DC + peak AC) on all ranges.

Full Range Step Response (to rated accuracy): 2 seconds.

Crest Factor: 3 at full range.

Over/Under Range Indication: None.

Frequency Response: Per AC voltage function.

Ranges:

ACV RANGE

200 mV

2 V

20 V

dB RANGE

- 60 to - 20

- 40 to 0

- 20 to + 20

4. RESISTANCE

Range	Maximum Indication	Accuracy	Typical Open-Circuit Voltage	Short-Circuit Test Current	Overload Protected To
200 Ω	199.9 Ω	$\pm (0.25\%$ of Input + 1 Count)	2.4 V	2 mA Max.	750 V (DC + peak AC) All Ranges
2 k Ω	1.999 k Ω		2.4 V		
20 k Ω	19.99 k Ω		0.6 V		
200 k Ω	199.9 k Ω		0.6 V		
2000 k Ω	1999 k Ω		0.6 V		
20 M Ω	19.99 M Ω	$\pm (1.0\%$ of Input + 1 Count)	2.4 V		

Full Range

Step Response: 1 second except 20 M Ω range which is 7 seconds.

Diode Test: Diode symbol indicated on 2 k Ω range. Measures forward resistance of a semiconductor junction, in k Ω , at approx. 0.5 milliamp.

Introduction

5. DC CURRENT

Range	Maximum Indication	Burden Voltage	Overload Protected To
200 μ A	$\pm 199.9 \mu$ A	0.25 V Max.	2 Amps Double Fuse Protected All Ranges
2 mA	± 1.999 mA		
20 mA	± 19.99 mA		
200 mA	± 199.9 mA		
2000 mA	± 1999 mA	1 V Max.	

Accuracy: $\pm(0.5\%$ of input + count) except
200 mA and 2000 mA range which
is $\pm(0.75\%$ of input + 1 count)

Full Range Step
Response (to
rated accuracy): 1 second

Overload

Protection: 2A/250 V fuse and 3A/600 V fuse
in series

6. AC CURRENT (AC coupled trms)

Range	Maximum Indication	Accuracy		Burden Voltage	Overload Protected To
		20 Hz to 40 Hz	40 Hz to 1 kHz		
200 μ A	199.9 μ A	$\pm(2.0\%$ of Input + 5 Counts)	$\pm(1.5\%$ of Input + 5 Counts)	0.25 V Max.	2 Amps Double Fuse Protected All Ranges
2 mA	1.999 mA				
20 mA	19.99 mA				
200 mA	199.9 mA				
2000 mA	1999 mA			1 V Max.	

Crest Factor
(at full scale): 3:1

Full Range Step
Response (to
rated accuracy): 3 seconds

Overload

Protection: 2A/250 V fuse and 3A/600 V fuse
in series

Introduction

7. BAR GRAPH

Sensitivity:	10 mV on 200 mV range, except dB: 1 dB, all ranges
Accuracy:	$\pm(5\%$ of input + 1 segment) except dB: $\pm(1$ dB + 1 segment)
Maximum Indication, 200 mV through 200 V, and 200 μ A through 200 mA ranges:	110% of range
Maximum Indication, 750 V AC, 1000 V DC, and 2000 mA ranges:	Limited to maximum input
Maximum Indication, dB: 200 mV through 20 V:	+ 20 dB (plus 2 dB over- range)
Full Range Step Response (to rated accuracy):	150 msec

8. DIFFERENTIAL PEAK HOLD DC VOLT AND DC CURRENT

Accuracy:	$\pm(1.0\%$ of input + 10 counts), DC volts $\pm(1.5\%$ of input + 10 counts), DC current
Acquisition Time:	10 msec minimum duration for square pulses
Display Decay Rate:	1 count/second

Introduction

AC VOLT AND AC CURRENT

(100 Hz to 1 kHz)

Accuracy:	$\pm(3\% \text{ of input} + 10 \text{ counts})$
Acquisition Time:	200 msec minimum

9. ABSOLUTE VALUE PULSE DETECTOR (200 k Ω range)

Reference Level:	Approx. $\pm 0.4 \text{ V}$
Display:	“▲” for absolute values greater than reference “▼” for absolute values less than reference (audio tone coincident with “▼” switch selectable) “◀▶” for inputs passing above and below reference
Pulse Response:	50 μS (minimum width of a 0 to $\pm 1 \text{ V}$ pulse required to turn on display “▲”. Pulse stretcher holds display for approx. 100 msec when narrow pulses are detected).
Input Impedance:	$>65 \text{ k}\Omega$ in parallel with $<100 \text{ pf}$, up to $\pm 35 \text{ V}$.
Overload Protection:	750 V (DC + peak AC)

10. CONTINUITY (200 & 2 k Ω ranges)

Display:	“▲” open circuit “▼” continuity (with switch activated tone).
Continuity Indicator:	Approximately 500 Ω or less in the 2 k range.

Introduction

Response Time: 50 μ sec (minimum duration of continuity or open to turn on display or audio tone). Pulse stretcher holds display and tone for approx. 100 msec.

Overload Protection: 750 V (DC + peak AC)

11. **RATED CIRCUIT-TO-GROUND VOLTAGE**  1000 volts (DC + peak AC) maximum from any terminal to ground (power line) except when the oscillator cable is connected, 30 V rms.
(maximum common mode voltage)

12. **TRANSIENT PROTECTION** (except the oscillator) Protected against transients on all voltage and resistance ranges: 6 kV @ 100 μ sec.

13. OSCILLATOR OUTPUT

Frequency: 1004 Hz $\pm$ 5 Hz
Amplitude: 0 dB $\pm$ 0.2 dB into 600 Ω .
Distortion: Less than 1%, sine wave.
Impedance: 600 Ω
Temperature Coefficient: 0° to +18°C and +28° to +55°C less than 0.1 Hz per degrees C and less than 0.02 dB per degrees C.

14. DISPLAY

Numerical Display: 3½ digit, 7 segment, 0.4" LCD

Introduction

Bar Graph:	LCD 20 segment bar graph with 2 segment overrange. Absolute value reading. Left-hand zero. (22 segments total.)
Conversion Rate:	
Numerical Display:	3 readings per second, nominal.
Bar Graph:	60 readings per second, nominal.
DC Polarity Selection:	Automatic “-” indication, “+” implied.
Overrange:	Indicated by a “1” only display (other digits blank-out).

15. POWER REQUIREMENTS*

Battery Life:	100 hours (see paragraph 1.1.5)
Battery Type:	(1) 9-volt “transistor” battery, alkaline (NEDA 1604A).
Low Battery Indicator:	Automatically displays “B” to signify a battery life of approx. 8 hours remaining.

*Applies to DC voltage and current ranges only.

16. TEMPERATURE RANGE

Operating:	0° to +55°C (+32° to +131°F)
Storage:	-40° to +60°C (-40° to +140°F)

Introduction

17. TEMPERATURE COEFFICIENT (0° to +18°C and +28° to +55°C). Less than 0.1 times the applicable accuracy specification per degrees C at 0° to +18°C (+32° to +65°F) and +28° to +55°C (+82° to +131°F).

18. RELATIVE HUMIDITY

Operating: 90% maximum up to +35°C (+95°F);
70% maximum up to +55°C (+131°F)
(non-condensing).

19. DIMENSIONS

Height: 2 in. (50.8 mm)
Width: 5.63 in. (143 mm)
Depth: 4.6 in. (116.8 mm)

20. WEIGHT: Approx. 1.5 lbs. (0.68 kg)

SECTION II PREPARATION FOR USE

2.1 GENERAL

2.1.1 This section contains instructions for preparing the new instrument for use. Included are unpacking and inspection procedures, warranty, shipping, power source requirements and operating position.

2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for obvious signs of damage. If damage is suspected, open the carton and inspect the Instrument for possible damage. If damage is noted, notify the carrier and supplier prior to using the Instrument. If the Instrument appears to be in good condition, read this Operator's Manual in its entirety. Then run a series of familiarity tests as instructed in this manual. Also, check that all items are included with the Instrument (Table 1-1).

2.3 WARRANTY

2.3.1 The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact any Authorized Service Center or the factory service department. Give details of any difficulty and include the Instrument model number, serial number (on the back of the Instrument) and date of purchase. Service data or shipping instructions will be mailed promptly. If an estimate of charges for nonwarranty or other service work is required, an estimate will be quoted. This charge will not be exceeded without prior approval.

2.4 SHIPPING

2.4.1 Pack the Instrument carefully and ship it prepaid and insured to the proper destination.

2.5 POWER SOURCE REQUIREMENTS

2.5.1 The 467 is a battery-operated instrument. An alkaline 9 V "transistor" battery is factory installed in the Instrument. (See item 15, Table 1-2 for battery type and paragraph 7.3 for installation.)

2.6 OPERATING POSITION

2.6.1 The Instrument may be operated in a horizontal (on its rubber feet) or vertical (on its back) position. It can also be set at an inclined angle by positioning the stand under the unit.

SECTION III

CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

3.1.1 Before attempting any operation of the 467, become familiar with each control. A thorough understanding of how the Instrument operates will avoid undue mistakes and prolong the life of the Instrument.

3.2 FRONT AND SIDE PANEL DESCRIPTION

3.2.1 This section, consisting of Table 3-1 and Figures 3-1 and 3-2, will describe the proper function of the 467.

Table 3-1.
Front and Side Panel Description

- | | |
|-----------------------|--|
| 1. Power Switch: | Pushbutton switch used to apply or turn off battery power to the Instrument. |
| ON | |
| OFF | |
| 2. Function Switches: | Connect the input to the appropriate measuring circuits as follows: |
| V | Selects the DC voltage or AC voltage measuring circuit, depending on the position of the $\overline{\text{DC}}/\text{AC}$ pushbutton switch. |
| mA | Selects the DC current or AC current measuring circuit, depending on the position of the $\overline{\text{DC}}/\text{AC}$ pushbutton switch. |
| ▲
▼
Ω | Selects the resistance measuring circuits in conjunction with the selection of any one of the six resistance range pushbutton switches; |
| | or |

selects pulse detection mode in conjunction with the selection of the 200 k $\blacklozenge$ pushbutton switch;

or

selects DIODE TEST in conjunction with the selection of the 2 k $\rightarrow|$ pushbutton switch;

or

selects CONTINUITY TEST in conjunction with the selection of the 2 k range. Continuity occurs with resistance of 500 ohms or less in the 2 k range.



The IN position selects the AC voltage or AC current measuring circuit, depending on the selection of either the V or mA pushbutton switch;

or

selects the audible buzzer for pulse detection and CONTINUITY in conjunction with the selection of the $\blacklozenge$ and the appropriate resistance range Ω pushbutton switches.

or

if either the V or mA is selected, then the 1004 Hz oscillator is activated. The position of the 600/AC/900 switch does not affect the operation of the oscillator.

or

if the AC and V are both selected, then the 600/AC/900 switch may be used to select either a 600 Ω /1 mW reference dB or a 900 Ω /1 mW reference dB or linear rms.

Controls, Connectors and Indicators

Pulse

Detection: “▲” for absolute values greater than approximately ± 0.4 volt.
“▼” for absolute values less than ± 0.4 volt.

Continuity: “▲” for open circuit,
“▼” for indication of continuity.

Low Battery: Low battery condition indicated by
B the symbol “B” located in the upper left-hand corner of the display. The first appearance of the “B” signifies a remaining battery life of approximately 8 hours.

600/AC/900 In conjunction with the AC and V switches, allows for dB measurements at either a 600 Ω /1 mW reference or 900 Ω /1 mW reference or linear rms measurements. (Use the AC position for all current, mA, measurements.)

PEAK
HOLD
“±” In conjunction with the “±” slide switch, selection of this pushbutton switch can be used to capture positive or negative peaks on any range of voltage or current being measured.

3. Range
Switches: Selects the appropriate circuits required to obtain full range measurements as follows:

Voltage: 200 mV, 2 V, 20 V, 200 V, 1000 V DC/
750 V AC

Current: 200 μ A, 2 mA, 20 mA, 200 mA, 2000 mA

Resistance: 200 Ω , 2 k, 20 k, 200 k, 2000 k, 20 M Ω

Continuity: 2 k range

Diode Test: 2 k

Controls, Connectors and Indicators

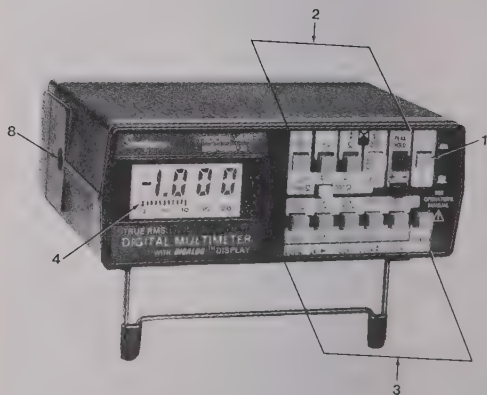


Figure 3-1. Front and Left Side Panel Description

Controls, Connectors and Indicators

Pulse

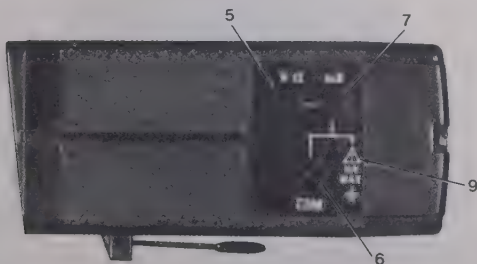
Detection: 200 k◆

dB 200 mV, 2 V, 20 V (− 60 to + 20 dB)

4. Display:

Numerical: The numerical display is a single LCD which includes a “−” polarity sign (“+” sign is implied), a “1” digit, three 7-segment 0 to 9 digits and a programmed decimal point, to indicate the polarity and the value of the signal being measured. Over-range (out-of-range) conditions are indicated by a blank display, but with the most significant “1” digit displayed.

Analog Bar graph: The LCD analog bar graph consists of 20 regular segments and 2 overrange segments. The analog bar graph provides absolute value reading and a left-hand zero scale.



Controls, Connectors and Indicators

5. **V- Ω Jack:** This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to all voltage and resistance measuring circuits through the range and function switches.
6. **COM Jack:** This jack is used to connect, via the black test lead, the "low" or "-" side of the circuit being measured to the internal circuit COMMON.
7. **mA Jack:** This jack is used to connect, via the red test lead, the "+" side of the circuit being measured to the current measuring circuits through the range and function switches.
8. **Oscillator Output Jack:** This jack is used to connect the 1004 Hz oscillator to the circuit under test.

CAUTION

Oscillator common is internally connected to the measuring circuit common.

WARNING

Do not float the input terminals more than 30 V rms from earth ground whenever the oscillator cable is attached.

9.  Refer to Table 1-2, item 11.
-

SECTION IV

OPERATING INSTRUCTIONS

4.1 SAFETY PRECAUTIONS



WARNING

Voltages encountered within the capabilities of this Instrument are dangerous and can be fatal. Read and follow fully the instructions provided in this Operator's Manual and adhere to the following:

4.1.1 Turn off circuit power before connecting and disconnecting test leads or oscillator cable.

4.1.2 Do not float the input terminals more than 1000 volts (DC + peak AC or 30 volts rms when the oscillator cable is connected) from earth ground.

4.1.3 Do not use this Instrument for making measurements in high voltage and high power circuits unless qualified to do so.

4.1.4 Do not exceed the following input limits:

Function	Maximum Input
AC/DC Volts, dB	1000 V (DC + peak AC)
AC/DC mA	2A (fuse protected)
OHMS	750 V (DC + peak AC)
Oscillator output	1/8 A, 250 V (fused)

Failure to stay below these limits can lead to damage to the Instrument and/or personal injury.

4.1.5 Disconnect the oscillator cable from the 467 whenever the oscillator is not being used.

4.1.6 Check and double check pushbutton settings and jacks being used before connecting test leads to any circuit.

Operating Instructions

4.1.7 Avoid touching the 467 or its test leads while energized when using the 1000 V DC or 750 V AC ranges.

4.1.8 For maximum safety, do not touch test leads, circuit or Instrument while power is applied to the circuit being measured.

4.2 BATTERY

4.2.1 This Instrument is powered by one 9 V alkaline battery (NEDA 1604A).

4.3 CURRENT RANGE FUSES

4.3.1 There are two fuses, F1 and F2, in series in the current measuring circuit. They are rated at 2A 250 V (3AG Normal BLO) and 3A 600 V (BBS), respectively.

4.4 DC VOLTAGE MEASUREMENTS

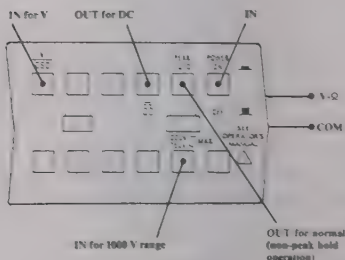


Figure 4-1. DC Volts

Operating Instructions

- a. Review the Safety Precautions in paragraph 4.1.
- b. Connect the red test lead to the V- Ω jack and the black lead to the COM jack.
- c. Depress the "V" function switch.
- d. Set the $\hat{A}\hat{C}$, $\overline{D}\overline{C}$ pushbutton switch to the $\overline{D}\overline{C}$ (OUT) position.
- e. Set the PEAK HOLD switch to the OUT position for normal operation.

WARNING

Do not attempt to measure voltages on the 1000 V DC range which might be greater than 1000 volts DC.

- f. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 1000 volt DC range switch.
- g. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.
- h. Connect test leads to the circuit being measured.
- i. Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity, " - " to indicate negative and no sign to imply positive polarity at the V- Ω jack. The value of the voltage being measured will be indicated on both the numerical and analog bar graph displays.
- j. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND WAIT FOR THE DISPLAY TO RETURN TO ZERO PRIOR TO DISCONNECTING TEST LEADS.

Operating Instructions

4.5 AC VOLTAGE MEASUREMENTS

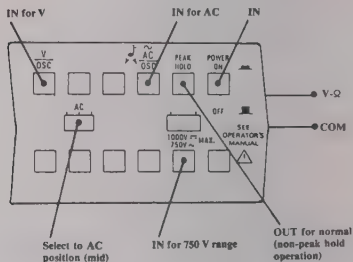


Figure 4-2. AC Volts

- Review the Safety Precautions in paragraph 4.1.
- Connect the red test lead to the V- Ω jack and the black lead to the COM jack.
- Depress the "V" function switch.
- Set the $\hat{A}\hat{C}$, $\overline{DC}$ pushbutton switch to the $\hat{A}\hat{C}$ (IN) position.
- Set the PEAK HOLD switch to the OUT position for normal operation.
- Set slide switch to "AC" position.

WARNING

Do not attempt to measure voltages on the 750 V AC range which might be greater than 750 volts.

Operating Instructions

- g. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 750 V AC range switch.
- h. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.
- i. Connect test leads to the circuit being measured.
- j. Apply power to the circuit being measured. The value of the voltage being measured will be indicated on both the numerical and analog bar graph displays.
- k. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND WAIT FOR THE DISPLAY TO RETURN TO ZERO PRIOR TO DISCONNECTING TEST LEADS.

4.6 DC CURRENT MEASUREMENTS

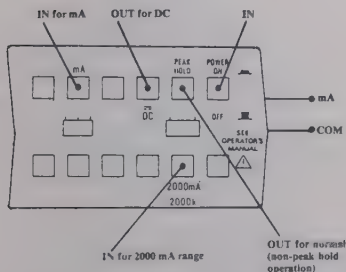


Figure 4-3. DC mA

Operating Instructions

- a. Review the Safety Precautions in paragraph 4.1.
- b. Connect the red test lead to the mA jack and the black test lead to the COM jack.
- c. Depress the “mA” function switch.
- d. Set the $\hat{A}\bar{C}$, $\bar{D}\bar{C}$ pushbutton switch to the $\bar{D}\bar{C}$ (OUT) position.
- e. Set the PEAK HOLD switch to the OUT position for normal operation.
- f. Depress the appropriate current range switch. If the current being measured is unknown, begin with the 2000 mA range.
- g. REMOVE ALL POWER TO THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.
- h. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 467 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of 1000 volts (*DC plus peak AC*).

- i. Apply power to the circuit being measured. The value of current being measured is indicated on the numerical display.
- j. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND WAIT UNTIL DISPLAY RETURNS TO ZERO PRIOR TO DISCONNECTING TEST LEADS.

Operating Instructions

- k. Disconnect the test leads and reconnect the circuit which was originally opened.

4.7 AC CURRENT MEASUREMENTS

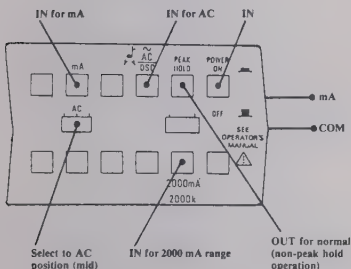


Figure 4-4. AC mA

- Review the Safety Precautions in paragraph 4.1.
- Connect the red test lead to the mA jack and the black test lead to the COM jack.
- Depress the "mA" function switch.
- Set the $\tilde{A}C$, $\overline{D}C$ pushbutton switch to the $\tilde{A}C$ (IN) position.
- Set the PEAK HOLD switch to the OUT position for normal operation.
- Set slide switch to "AC" position.
- Depress the appropriate current range switch. If the current being measured is unknown, begin with the 2000 mA range.

Operating Instructions

- h. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 467 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of 1000 volts (*DC plus peak AC*).

- i. Open the circuit in which the current is to be measured and securely connect the test leads in series.
- j. Apply power to the circuit being measured. The value of the current being measured is indicated on the numerical display.
- k. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND WAIT UNTIL DISPLAY RETURNS TO ZERO BEFORE DISCONNECTING TEST LEADS.
- l. Disconnect the test leads and reconnect the circuit which was originally opened.

4.8 RESISTANCE MEASUREMENTS

- a. Connect the red test lead to the V- Ω jack and the black lead to the COM jack.
- b. Depress the “ Ω ” function switch.
- c. Set the $\tilde{\text{AC}}$, $\overline{\text{DC}}$ pushbutton switch to the $\overline{\text{DC}}$ (OUT) position.

Operating Instructions

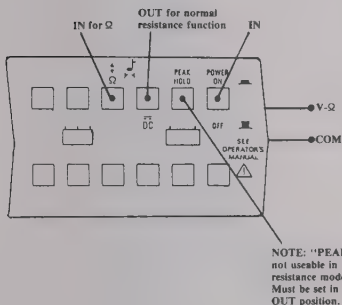


Figure 4-5. Resistance

- d. Depress the appropriate resistance range switch.
- (1) Low Power (0.6 V open-circuit voltage) 20 k, 200 k and 2000 k Ω ranges.
 - (2) Standard Power (2.4 V open-circuit voltage) 200, 2 k and 20 M Ω ranges.

NOTE: If the resistance being measured is connected into a circuit, be certain that all power is removed from the circuit and all capacitors are discharged. Check for current paths other than through the resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

- e. Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the actual value.

Operating Instructions

- f. Allow time for the display to stabilize. This procedure is especially important when measuring a high value resistance shunted by a large value of capacitance.
- g. Disconnect test leads.

4.9 CONTINUITY MEASUREMENTS

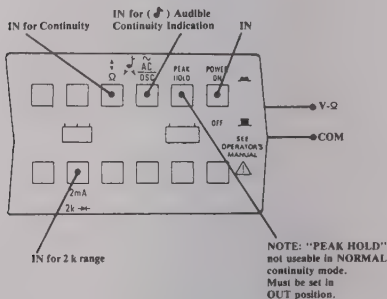


Figure 4-6. Continuity

- a. Connect the red test lead to the V- Ω jack and the black test lead to the COM jack.
- b. Depress the " Ω " pushbutton switch.
- c. Depress the "2 k $\rightarrow$ $\vdash$ " range switch.
- d. Continuity (less than 500 Ω) is indicated by a downward pointing arrow " ∇ ."
- e. Depress the $\tilde{\sim}$ AC pushbutton switch for an audible continuity indication.
- f. The Instrument responds to continuity of 50 μ sec or longer duration.

4.10 DIODE TEST

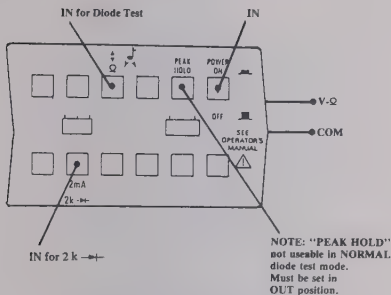


Figure 4-7. Diode Test

- The diode to be tested must be out of circuit.
- Connect the red test lead to the V-Ω jack and the black test lead to the COM jack.
- Depress the "Ω" pushbutton switch.
- Depress the "2 k →|←" range switch.
- Connect the "V-Ω" test probe to the anode of the diode and the "COM" test probe to the cathode of the diode.
- The forward resistance with a 0.5 mA current will be displayed. A reading of .550 to .950 is a typical value for silicon diodes.
- Reverse the leads; the numerical display should show overrange.

Operating Instructions

4.11 PEAK HOLD

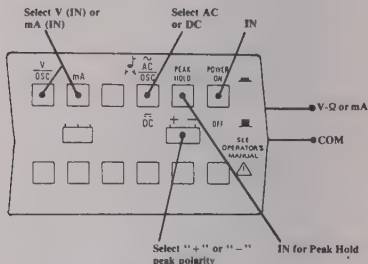
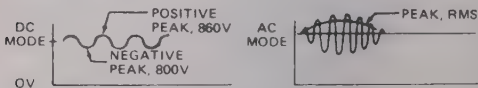


Figure 4-8. Peak Hold

4.11.1 PEAK HOLD can be used to capture positive and negative peaks of voltages and currents on the digital display.



4.11.2 Procedures:

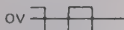
- Follow the procedure (and warnings) listed for the function desired.
- To measure peaks, operate the PEAK HOLD control switches as described below for the appropriate input condition (A, B or C).
- To make a new measurement, first release the PEAK HOLD switch (out position) to clear the previous reading.

NOTE: Using PEAK HOLD in the Resistance Measurement mode will result in erroneous readings.

CONDITION A



CONDITION B



CONDITION C



For holding the most POSITIVE value:

- | | | |
|--|--|--|
| 1. Set the “ $\pm$ ” switch to the “+” position | 1. Set the “ $\pm$ ” switch to the “+” position | 1. Perform the procedure below for most NEGATIVE value |
| 2. Set the “PEAK HOLD” switch to the IN position | 2. Set the “PEAK HOLD” switch to the IN position | 2. Set the “ $\pm$ ” switch to the “+” position |

For holding the most NEGATIVE value:

- | | | |
|--|--|--|
| 1. Perform the procedure above for the most POSITIVE value | 1. Set the “ $\pm$ ” switch to the “-” position | 1. Set the “ $\pm$ ” switch to the “-” position |
| 2. Set the “ $\pm$ ” switch to the “-” position | 2. Set the “PEAK HOLD” switch to the IN position | 2. Set the “PEAK HOLD” switch to the IN position |

4.12 ABSOLUTE VALUE PULSE DETECTOR

NOTE: In the absolute value pulse detector mode, the reading of the digital display is meaningless.

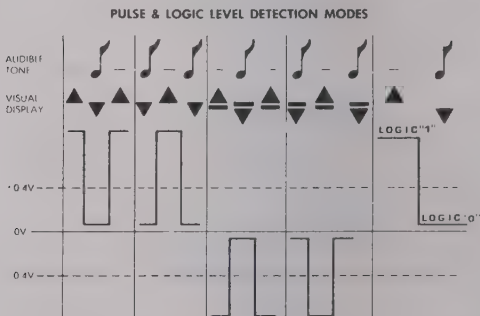
4.12.1 The absolute value pulse detector automatically detects and indicates the presence of either positive or negative pulses.

4.12.2 To be detected, the pulse must have a minimum pulse width of 50 μ sec and must exceed a reference level of approximately ± 0.4 V DC.

Operating Instructions

4.12.3 Procedures:

- Connect the red test lead to the "V- Ω " jack and the black test lead to the "COM" jack.
- Depress the " $\blacktriangle$ " and "200 k $\blacktriangle$ " switches.
- If an audible signal (corresponding to the " $\blacktriangledown$ " arrow) is desired, depress the AC, DC switch.
- Follow the instructions for the resistance function.
- The display and buzzer indications for various input signals are shown below:



4.13 ANALOG BAR GRAPH DISPLAY



4.13.1 The analog bar graph display provides a rapid indication of either voltage or current signal levels, offering the advantages of an analog meter in a digital instrument.

Operating Instructions

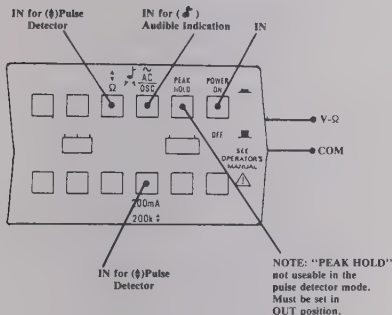


Figure 4-9. Absolute Value Pulse Detector

4.13.2 The bar graph reading corresponds to the numerical reading in both AC/DC volts and AC/DC mA functions. In addition, the bar graph can be used to perform the following:

- In DC volts or DC mA functions, follow changes in varying inputs. Applications would include nulling, peaking and observation of AC frequencies below 30 Hz.
- Observe instantaneous AC/DC volts or AC/DC mA readings when PEAK HOLD is in use. The input will still be monitored and displayed on the bar graph after PEAK HOLD has captured a peak on the numerical display.

4.13.3 The bar graph displays absolute values, with “-” polarity provided by the numerical display; “+” is implied.

4.13.4 The bar graph will display 110% of the range selected. An arrow pointing to the right indicates over-range conditions.

Operating Instructions

4.14 dB MEASUREMENT

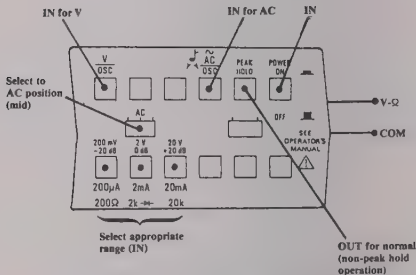


Figure 4-10. dB Measurement

- a. Review the Safety Precautions in paragraph 4.1.

WARNING

If the oscillator cable is attached, do not float the 467 more than 30 V rms above earth ground.

- b. Connect the red lead to the V- Ω jack and the black lead to the COM jack.
- c. Depress the V function switch.
- d. Depress the $\tilde{A}C$, $\overline{D}C$ pushbutton switch to the $\tilde{A}C$ (IN) position.
- e. Set the PEAK HOLD switch to the position for normal operation (OUT).
- f. Set the PEAK HOLD slide switch for "AC."

WARNING

Do not attempt to measure voltages on the 750 V AC range which might be greater than 750 V.

- g. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 750 V AC range switch.
- h. After establishing that the AC voltage potential is under 20 V AC (77 V AC if voltage is known to be sinusoidal), set the 600/AC/900 slide switch for the appropriate dB reference level.

NOTE: The 2 V AC (0 dB) range will cover the range of -40 to +20 dB if measuring sinusoidal voltages. This range also has the widest typical frequency response and therefore is generally the optimum range for most telecommunications applications.

- i. Depress the appropriate "dB" range switch established by the AC voltage potential.

4.15 OSCILLATOR OUTPUT

- a. Review the safety precautions in paragraph 4.1.
- b. The oscillator is operative anytime the Instrument is set for AC voltage or current measurements.
- c. Before connecting the oscillator cable to the Instrument, use the AC and DC voltage measuring functions of the Instrument to make certain that no AC or DC voltages are present in the circuit to be tested (voltage applied to the oscillator output may blow the internal 1/8 A fuse.) To avoid electric shock, also check that the circuit conductors to be tested do not have a voltage, with respect to earth ground, exceeding 30 V AC or 60 V DC.
- d. Set the pushbuttons to measure AC V (see paragraph 4.5).

Operating Instructions

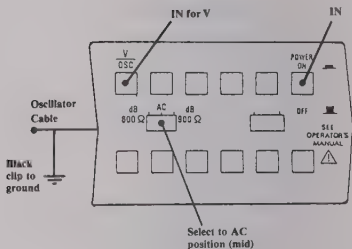


Figure 4-11. Oscillator Output

- e. Connect the oscillator cable to the recessed jack on the left side of the Instrument.

CAUTION

The black clip of the oscillator cable is common with the **COMMON** jack of the measuring circuits. If using the oscillator and measuring functions simultaneously, observe the same polarity of the leads. If the circuit being tested is ground referenced, connect the black lead(s) to the ground side of the circuit.

- f. Connect the red clip to the other side of the circuit.
- g. Immediately disconnect the oscillator cable from the circuit and from the Instrument when testing is complete. The cable clips can be a shock hazard if the Instrument is used to make measurements above 30 V AC with the oscillator cable attached.

SECTION V

THEORY OF OPERATION

5.1 OVERALL SYSTEM

5.1.1 The basic system block diagram for the Instrument is shown in Figure 5-1.

5.1.2 Signal Conditioning Section

The parameter being measured is connected to the input terminals. The corresponding Signal Conditioning circuits convert this parameter into a proportional DC voltage. The conversion is accomplished by the Attenuator, Current Shunts, Resistance Converter, Peak Hold, True RMS to DC Converter, dB Converter and associated switching.

5.1.3 Analog-to-Digital Converter Section

The A/D Converter section consists of the basic A/D Converter, the Bar Graph Converter, and the Pulse and Continuity Detector. The two-slope A/D Converter changes the DC output voltage from the signal conditioning section to digital information to drive the numerical display. The single-slope Bar Graph Converter changes the DC output voltage from the signal conditioning section to drive a 22-segment bar graph display. The Pulse and Continuity Detector determines whether or not the conditioned input DC voltage level or pulse exceeds a predetermined reference level and appropriately activates either the upward or downward arrow on the display.

5.1.4 Display Section

The A/D Converter decodes the BCD into 7-segment information by the onboard decoder-driver. The numerical display is driven directly by the A/D Converter LSI chip. The analog information is also processed by the Bar Graph CMOS LSI, which in turn drives the 22-segment analog bar graph. The arrows are being driven by the Pulse and Continuity Detector to indicate the level of the incoming DC voltage or pulse.

Theory of Operation

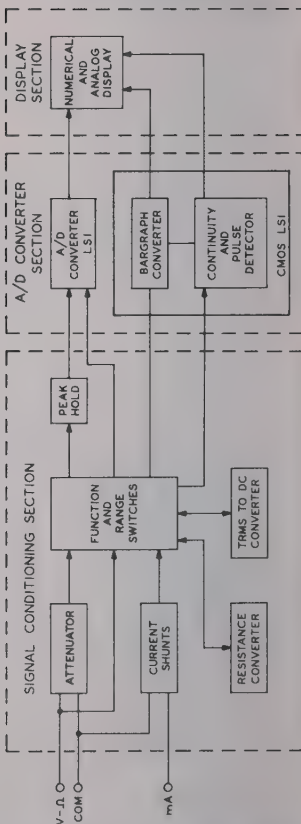


Figure 5-1. Basic System Diagram

Theory of Operation

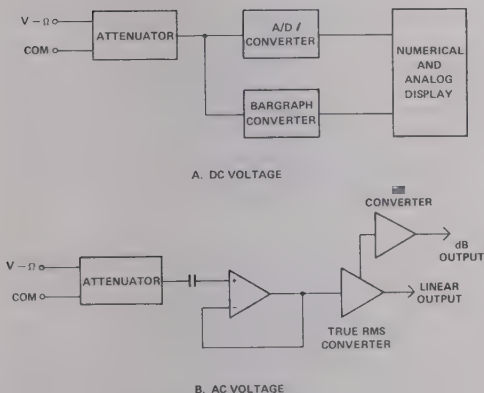


Figure 5-2. Basic Voltage Measurement Circuits

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements

The basic DC voltage circuit is shown in Figure 5-2(A). The DC voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected and converted into digital information by the A/D Converter.

The A/D Converter provides a basic 200 mV sensitivity range. The input voltage being measured is attenuated to provide 200 mV by the input divider network. The divider network is used on the 2 V, 20 V, 200 V and 1000 volt ranges.

5.2.2 AC Voltage Measurements

The basic AC voltage measurement circuit is shown in Figure 5-2(B). The AC voltage being measured is connected to the "V- Ω " and "COM" jacks, attenuated according to the range selected and applied to the amplifier. The output of the amplifier is converted into DC voltage by a True RMS Converter and the resulting 200 mV DC voltage is measured by the A/D Converter. A buffer is used between the Attenuator and the True RMS Converter.

True rms conversions are limited by their crest factors as to the type of waveform which can be measured. The crest factor is defined as the ratio of the peak value to the rms value of a periodic waveform.

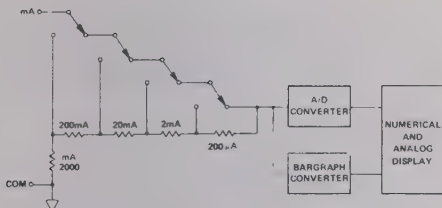
Decibel (dB) measurements are a function of the True RMS Converter. The True RMS Converter provides a proportional current output that is converted to a DC voltage. This circuitry is external to the True RMS Converter. Both 600 Ω and 900 Ω reference levels are processed by the True RMS Converter.

5.2.3 DC Current Measurements

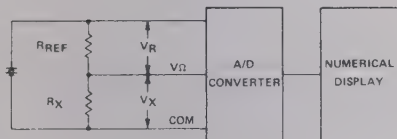
The basic DC current measurement circuit is shown in Figure 5-3(A). The current being measured is connected in series with the "mA" and "COM" jacks across the internal precision shunt resistance. The value of the shunt resistance depends on the current range selected. The DC voltage developed across the shunt resistor is measured by the A/D Converter.

The full range sensitivity of the A/D Converter is set for 200 mV. The internal shunt resistance for each current equals 200 mV divided by the full range current. For example, if the full range current is 200 μ A, the shunt resistance is 1000 ohms.

Theory of Operation



A. AC CURRENT



B. RESISTANCE

Figure 5-3. Basic DC Current and Resistance Measurement Circuits

5.2.4 AC Current Measurements

The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (paragraph 5.2.3), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

5.2.5 Resistance Measurements

The basic resistance circuit is shown in Figure 5-3(B). The resistance being measured, R_X , is connected to the "V-Ω" and "COM" jacks. A voltage ratio is made by comparing the unknown resistance (R_X) with an internal standard resistance (R_{ref}). The voltage ratio is applied

Theory of Operation

to the A/D Converter to yield a numerical value which is proportional to the unknown resistance as shown in Figure 5-3(B). The ranges of the resistance measurement circuit are determined by the range switch selected.

5.2.6 Peak Hold

A simplified block diagram of the Peak Hold circuit is shown in Figure 5-4. The "Peak Hold" circuitry consists of a storage capacitor, a diode and two isolation amplifiers connected in a unity gain configuration. Initially, the C_s capacitor is discharged. When the "Peak Hold" pushbutton is depressed, the C_s capacitor is charged to the most positive potential of the input signal via IC202. Once the most extreme potential is removed, the diode is reverse biased and the potential is stored in the C_s capacitor. The decay rate of the stored potential is about one count per second.

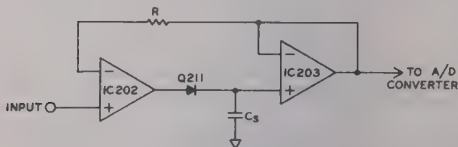


Figure 5-4. Simplified Block Diagram,
Peak Hold Circuit

5.3 SPECIAL CIRCUITS

5.3.1 Bar Graph Converter

A simplified block diagram of the Bar Graph Converter is shown in Figure 5-5. The Bar Graph Converter is a single-slope, 60 sample per second, absolute value A/D circuit that interfaces with a 22-segment liquid crystal display.

Theory of Operation

The Input Buffer consists of an amplifier with a gain of five (5) amplifiers and an absolute value converter. The output of the absolute value converter is always negative.

A 60 Hz reset pulse, derived from the LCD backplane, is used to synchronize the conversion. The Comparator enables the clock from the falling edge of the reset pulse to the point where the timing capacitor voltage exceeds the voltage at the input buffer output. The number of segments displayed equals the number of clock pulses generated. The shift register is reset with every conversion cycle.

5.3.2 Pulse and Continuity Detector

A simplified block diagram of the Pulse and Continuity Detector is shown in Figure 5-6. The absolute-value input signal is compared with a reference voltage at IC101B Comparator. The Bar Graph CMOS LSI has 2 internal edge-triggered clocked latches, one for positive edges and one for negative edges. Their inputs are from the Comparator and their outputs control the "▲" and "▼" symbols. Each symbol remains on for the time that the input remains high or low, respectively, plus 100 msec.

If the front panel pushbutton switch "AC, DC" (IN position) is selected in conjunction with the pulse-on continuity detection switch, an audio tone coincident with the down arrow "▼" symbol will be generated. The tone is generated by a piezoelectric element operated by a push-pull driver.

Continuity is a special case of a "below reference" level and, therefore, turns on the "▼" symbol when the input test leads are "shorted." Conversely, an open circuit or a "non-short" condition represents the "above reference" level and turns on the "▲" symbol.

Theory of Operation

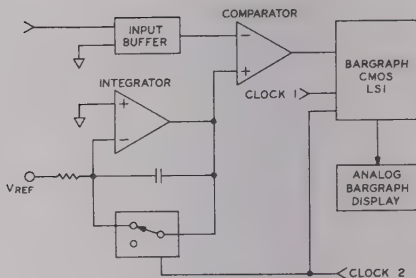


**Figure 5-5. Simplified Block Diagram,
Bar Graph Converter**

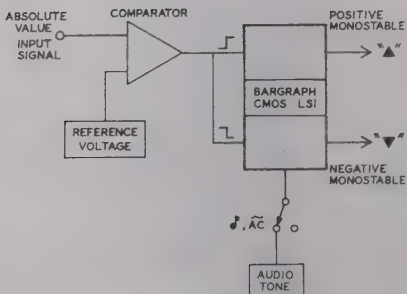


**Figure 5-6. Simplified Block Diagram
of Pulse and Continuity Detector**

SECTION VI APPLICATIONS

6.1 GENERAL

6.1.1 There are five special functions available with the 467 which expand the test and measurement capabilities of the Instrument. The four functions are:

- a. Peak Hold
- b. Analog Bar Graph
- c. Absolute Value Pulse Detector
- d. dB
- e. 1004 Hz Oscillator

In this section a few interesting and useful applications of these special functions will be described.

6.2 MEASUREMENT OF LOW FREQUENCY WAVEFORMS

6.2.1 Typical digital multimeters are unable to give accurate or stable readings of AC voltages or currents with frequencies below approximately 10 Hz. This deficiency is due to the signal frequency approaching the DMM sampling rate. However, by using the 467, accurate peak-to-peak measurements can be made, and the waveform can be visually observed if the input frequency is below approximately 5 Hz.

6.2.2 As an example of the low frequency signal measurement application, consider a servo-control system in which the position of a slowly rotating shaft is converted into a voltage proportional to the sine of the shaft's angular position. The test setup required is shown in Figure 6-1.

6.2.3 To measure the low frequency signal shown in Figure 6-1, use the following procedure:

- a. Connect the test leads from the "V- Ω " and "COM" input jacks across the leads of the shaft position indicator transducer.

Applications

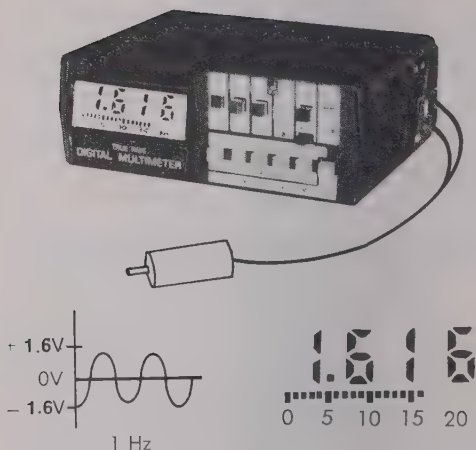


Figure 6-1. Low Frequency Measurements

- b. Set the “V”, $\overline{\text{DC}}$ and “2 V” pushbutton switches of the 467.
- c. Turn on the servo-control system. The analog bar graph will move from 0 to 16, back down to 0, and back up to 16, but with the minus sign displayed in the numerical display. It will then return to 0, and the cycle will repeat. The movement of the bar graph provides a visual indication of the shaft motion.
- d. Depress the PEAK HOLD button. The positive peak voltage (+ 1.6 V) will be held and displayed as shown in Figure 6-1. Note that the bar graph is still following the input signal. The bar graph is not affected by the peak hold function.

6.3 PEAKING AND NULLING

6.3.1 Analog (moving pointer) meters have traditionally been preferred over digital instruments for applications requiring trend analysis. These include peaking and nulling, in which the absolute reading is less important than the variation in the reading. For these applications ignore the numerical display and observe the movement of the analog bar graph display, which is analogous to the moving pointer. Once a peak or null has been reached, the reading of the signal can be taken from the numerical display.

6.4 USE OF THE 467 AS A LOGIC PROBE

6.4.1 The use of digital electronics has spread into the consumer field, with applications in even low-priced appliances and entertainment products, as well as through the industrial market. For this reason, a logic probe to analyze these digital circuits is becoming increasingly useful.

6.4.2 In essence, a logic probe indicates the logic state at a point in a digital circuit. This state will be a "1" or a "0." A "1" state most often indicates a positive voltage, and a "0" state is near circuit ground (there are circuits which use negative logic, but this is compensated for by the 467, which operates as an absolute value logic probe). The level of a "1" state is usually between +2.5 and +5 V DC for TTL, and between +5 and +15 V DC for CMOS logic circuitry.

6.4.3 As an example of the logic probe function of the 467, consider a digital circuit putting out a string of pulses with various repetition rates. The circuit uses CMOS, with a "1" being +15 V DC and a "0" being circuit ground. The test setup and pulse train are shown in Figure 6-2.

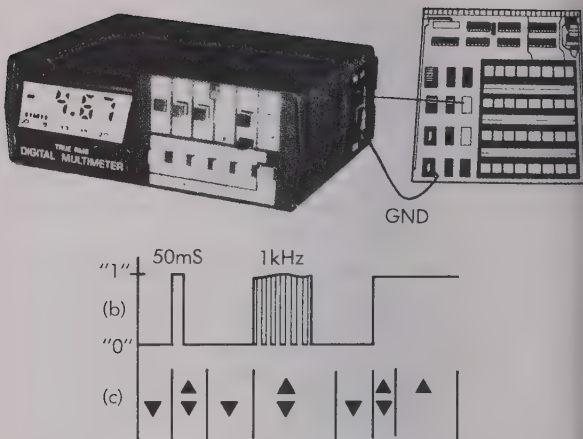


Figure 6-2. Use of 467 as a Logic Probe

6.4.4 To analyze the logic waveform shown in Figure 6-2:

- Connect the test lead from the "COM" input jack to the circuit ground. Connect the test lead from the "V-Ω" input jack to the point in the circuit to be analyzed.
- Depress the " ∇_{Ω} " and "200 k $\blacktriangle$ " buttons. If desired, the continuity buzzer can be turned on by depressing the " $\sim$ AC, $\overline{\text{DC}}$ " button. The buzzer will coincide with the " ∇ " display.
- The logic waveform in Figure 6-2 will produce the display shown. Note that the reading in the numerical

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display is meaningless. Also note that the pulse stretcher circuit in the 467 will keep either the “▲” or the “▼” display element on for approximately 100 msec after the logic state changes. This enables the operator to detect pulses as short as 50 μ sec in duration. This also means, however, that detected changes in state slightly lag the actual changes, as shown in the figure.

6.5 LOCATION OF WIRING INTERMITTENTS

6.5.1 It is sometimes necessary to locate an intermittent wire or connection in a piece of equipment. This can be very time-consuming if the intermittent is infrequent or of very short duration.

6.5.2 To use the 467 to locate an intermittent:

- a. Connect the test leads from the “V- Ω ” and “COM” input jacks across the wire or connection which is suspected of being intermittent. Depress the “ Ω ” and “200 Ω ” buttons.
- b. With continuity indicated, depress the PEAK HOLD button.
- c. If the reading on the Instrument is later seen to be higher than when the PEAK HOLD button was depressed, an intermittent has occurred.
- d. The continuity indicator is unaffected by the PEAK HOLD function, and can be used to indicate continuity at the present moment.

6.6 PEAK IN-RUSH CURRENT MEASUREMENTS

6.6.1 Most types of line-operated equipment, from motor driven appliances to consumer electronic products, draw a heavy surge of line current when they are turned on. This current may be many times the rated operating current of the product. It is occasionally desirable to measure this surge current.

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6.6.2 As an example of the in-rush current measurement application: suppose that a television set, which draws 1 ampere when operating, is to be checked for peak in-rush current to make certain that a replacement power switch is capable of handling the surge. Since the in-rush current is likely to be over two amperes, the limit of the 467 current measurement capability, a Simpson 153-2 Amp-Clamp will be used (current range from 2 amps to 200 amps). The setup required is shown in Figure 6-3.

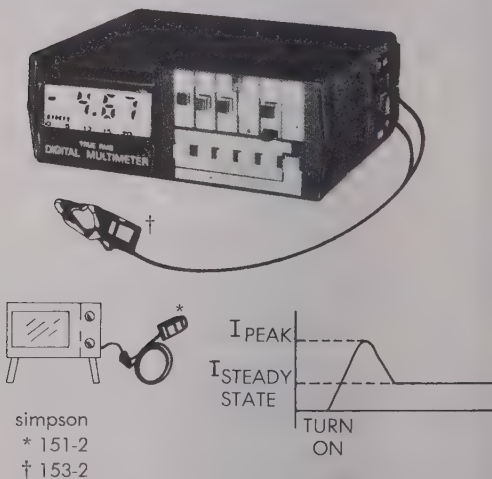


Figure 6-3. In-Rush Current Measurement

6.6.3 To measure the input surge current:

- Close the Amp-Clamp jaws around one side of the AC supply cord. This can be done conveniently by using a Simpson 151-2 Line Splitter.

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- b. Connect the Amp-Clamp to the "V-Ω" and "COM" input jacks.
- c. In this case, a surge current between 2 and 20 amps is expected, so the Amp-Clamp is set to the "20 A" position. Referring to the chart on the Amp-Clamp body, the "2 V" button on the 467 is depressed. Depress the "V" button. Set for "DC."
- d. With the 467 reading 0, depress the PEAK HOLD button.
- e. Turn on the television set. The peak in-rush current will be captured in the numerical display.
- f. Set for "AC", "V" and release the PEAK HOLD switch to measure the steady-state current.

6.7 dB MEASUREMENT

6.7.1 The procedure for taking decibel (dB) measurements is quite similar to AC voltage measurements. The 467 was designed to operate with a reference voltage based on a power dissipation of 1 mW into either a 600 Ω or 900 Ω load.

Specifically, the dB functions are based on the following equations:

$$\text{For } 600 \, \Omega \text{ references, } \text{dB} = \frac{20 \log V}{0.7746}$$

$$\text{For } 900 \, \Omega \text{ references, } \text{dB} = \frac{20 \log V}{0.9486}$$

where V is the input voltage being measured.

6.7.2 For decibel measurements on circuits with resistance other than 600 Ω or 900 Ω, apply the proper correction factor to the 467s by the following formula:

$$\Delta \text{dB} = \frac{-10 \log R}{600}$$

where R is the resistance of the circuit being measured.

Applications

6.8 1004 HERTZ OSCILLATOR

6.8.1 The 1004 Hz Oscillator is useful in making telephone line-loss measurements. Refer to Figure 6-4.

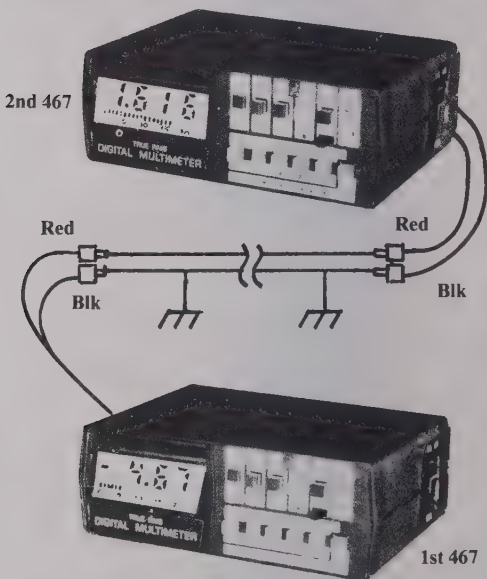


Figure 6-4. Telephone Line-Loss Measurement

6.8.2 The first 467 in the figure has its oscillator output connected to the telephone line and the second 467 is set up to measure 600 Ω dB. The line loss is read out in dB on the second 467.

SECTION VII OPERATOR MAINTENANCE

7.1 GENERAL

WARNING

Improper repairs can be dangerous to the operator of the Instrument. Servicing other than as described in this section should be performed only by qualified personnel. Refer to Section VIII.

7.2 BATTERY AND FUSE ACCESS

7.2.1 The rear cover can be removed for battery and fuse access by the following procedure.

WARNING

Disconnect the test leads from any circuitry and from the Instrument before removing the cover. Do not use the Instrument to make any measurements without first replacing the cover.

- a. Set the power switch OFF (OUT).
- b. Unscrew the two captive screws from the back until the cover is free to be removed.

7.3 BATTERY REPLACEMENT

7.3.1 This Instrument is powered by one 9 V alkaline battery (NEDA 1604A). When the battery is nearing the end of its useful life, the symbol B will appear at the upper-left corner of the display indicating that it has less than 8 hours' operating life remaining.

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7.3.2 The battery may be replaced by the following procedure.

- a. Set the power switch to OFF (OUT).
- b. Remove the back cover in accordance with paragraph 7.2 above.
- c. Lift the old battery (if any) from its compartment and remove the battery connector.
- d. Press the connector onto the new battery terminals and place battery in compartment.
- e. Replace the back cover.

NOTE: Replace a weak battery promptly. Failure to do so may result in corrosion at the battery terminals.

7.4 FUSE REPLACEMENT

7.4.1 The 467 utilizes two fuses in series in the current measuring circuits. To determine that a fuse has been blown, depress the Ω and 2 k Ω pushbuttons, connect the test leads to the V- Ω and mA jacks and short the test prods together. If the display indicates over-range, one or both fuses are blown.

7.4.2 Fuses can be replaced by the following procedures.

- a. Set the power switch to OFF (OUT).
- b. Remove the back cover in accordance with paragraph 7.2 above.
- c. Using the procedure in paragraph 7.4.1, short across the fuse or fuses until the display indicates near .001. The fuse (or fuses) which cause the display to indicate .100 when shorted is (are) blown.
- d. The correct fuses to use are:
F1 (small glass) Type 3AG, 2 A, 250 V,
F2 (large) Type BBS, 3 A, 600 V.

WARNING

The combination of two fuses provided in this Instrument will perform properly only when the specified type and rating fuses are used. Incorrect substitutions can endanger the Instrument and operator when subjected to a severe overload.

- e. Replace the defective fuse or fuses.
- f. Replace the cover before making any measurements with the Instrument.

7.5 CARE

7.5.1 General

Dirty, contaminated, missing or damaged insulation can be dangerous to the operator. Before each day's usage, particularly if the Instrument is shared with others, inspect all the insulation of the Instrument and its test leads. Have all damaged or otherwise faulty parts replaced before using the Instrument.

Dirty or contaminated insulation can absorb and retain moisture and become conductive. When accumulations are observed, clean the insulation with a clean cloth dampened with a mild detergent-water solution. Rinse with a rag dampened with clean water and dry thoroughly before use. Do not allow **any** liquids to enter the case and avoid chemical solvents that may damage the plastic insulation.

7.5.2 Performance and Accuracy Verifications

All electrical measuring instruments should be checked for performance and accuracy in all functions and ranges periodically to detect gradual performance deterioration that might not be noticed in regular usage of the Instrument. The frequency of such checks is determined by

Operator Maintenance

the measurement accuracy required, the availability of suitable calibration standards, and the Instrument's past history. If monthly checks indicate the Instrument to be stable, the check periods can be extended accordingly. If the Instrument's accuracy specifications are important, the Instrument should be checked at least once or twice yearly, more often if warranted.

7.6 TROUBLESHOOTING

7.6.1 If the Instrument does not yield satisfactory results, follow these procedures before attempting maintenance on the Instrument.

- a. Check that the PEAK HOLD pushbutton switch is set to the OUT position for normal operations.
- b. Check that all switches are positioned correctly for parameter and range of the input being measured and that the measurement situation is within the rating of the Instrument.
- c. Be sure that the battery is properly installed (refer to paragraph 7.3).
- d. Ensure that the environment in which the Instrument is being used is within the Instrument specifications.
- e. Inspect the device being measured and the measurement test setup to ensure that proper shielding and grounding techniques have been used. Also, consider whether the Instrument is significantly affecting the circuit being measured.

7.6.2 If the steps taken in paragraphs 7.6.1 do not yield satisfactory results, refer to the troubleshooting chart (Table 7-1). If further assistance is needed, contact the Authorized Service Centers .

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Table 7-1. Troubleshooting Chart

- Symptom: Symbol "B" appears on display.
Probable Cause: Battery reached the end of its useful life.
Cure: Replace the battery as noted in paragraph 7.3.
- Symptom: No display or faded display when the Instrument is turned "ON."
Probable Causes: Battery defective, not installed properly, making poor contact or missing.
Cure: Remove cover and check that the battery is installed correctly and making good contact (refer to paragraph 7.3 for replacement).
- Symptom: Indications fluctuate and/or drift, even though indication is satisfactory at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance source.
Probable Cause: Fluctuations, and/or drift are being generated by the circuit being measured or the measurement test setup.
Cure: Use proper shielding grounding techniques and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling.
- Symptom: Slow response. Operation OK when using a low impedance input.
Probable Cause: Parameter being measured has a high source impedance.
Cure: None required.
- Symptom: Accuracy not within specifications when checked with a stable higher accuracy (at least 5 times better) low impedance (voltage measurements) source.

Operator Maintenance

Probable Cause: Instrument is out of calibration.

Cure: Contact the Authorized Service Center.

- Symptom: Operation normal on all functions and ranges except AC and DC Current.

Probable Cause: Current fuse F1 open.

Cure: Replace fuse F1 (refer to paragraph 7.4).

- Symptom: Operation normal on all functions and ranges except AC and DC Current (F1 checks OK).

Probable Cause: Current fuse F2 open.

Cure: If F2 has been blown, a large amount of energy has been applied to the current ranges. Circuit conditions must be evaluated before replacing F2.

- Symptom: The oscillator has no output.

Probable Cause: Protective fuse open.

Cure: Be certain that the battery and oscillator cable are good. Check that the "V" and "AC" are selected. If OK, then contact the Authorized Service Center for fuse replacement.

7.7 STORAGE AND TRANSPORT

When the Instrument is not in use, store it in a location free from temperature extremes, high humidity, dust and corrosive fumes, and mechanical shock and vibration. When transporting the Instrument, protect it as much as possible from the above conditions. A protective carrying case can be a good investment.

NOTE: When an instrument has been in a cold location for any period of time and is brought into a warm location, it may experience condensation. Do not make measurements in high voltage circuits until it has been allowed to dry thoroughly.

SECTION VIII

SERVICE INFORMATION

WARNING

The information in this section is for use by qualified repair personnel only. To reduce risk of electric shock, do not perform any servicing other than that contained in the Operator Maintenance section of this manual unless you are qualified and have been specially trained to do so.

8.1 GENERAL

This section of the manual contains a replacement parts list and a circuit diagram of the Instrument.

Table 8-1. Replacement Parts

Symbol	Description	Number
	Battery, 9 V Alkaline (NEDA 1604A)	5-114907
	Test Lead Set Catalog No. 00043	10-864590
F1	Fuse, 2 A, 250 V, 3AG	1-112911
F2	Fuse, 3 A, 600 V, BBS	6-110906
F3	Fuse, 1/8 A, 125 V, Picofuse	5-115485
C100	Capacitor, 56 pF, 5%, 100 V	5-119655
C101	Capacitor, Variable, 1-5 pF	5-119544
C102	Capacitor, 2000 pF, 20%, 1 kV	1-113855
C103	Capacitor, 0.047 μ F, 10%, 100 V	6-113517
C104	Capacitor, 68 pF, 2%, 160 V	5-119597
C105	Capacitor, 0.47 μ F, 20%, 50 V	6-113465
C106, 209, C210, 301, C304, 305	Capacitor, 15 μ F, 20%, 16 V	6-113031

Servicing Instructions

Symbol	Description	Number
C108	Capacitor, 2.2 pF, 10%, 1 kV	5-114987
C107, 200	Capacitor, 0.1 μ F, 100 V	5-113883
C201	Capacitor, 47 pF, 10%, 160 V	5-115992
C202	Capacitor, 0.1 μ F, 10%, 100 V	6-112365
C203	Capacitor, 0.22 μ F, 10%, 100 V	6-113466
C204	Capacitor, 470 pF, 500 V	1-115832
C205, 206,		
C211	Capacitor, 0.047 pF, 5%, 100 V	5-117202
C207	Capacitor, 100 pF, 10%, 1 kV	5-113217
C208	Capacitor, 100 μ F, 10 V	5-117206
C212	Capacitor, 3.3 μ F, 10 V	5-117605
C213	Capacitor, 15 μ F, 16 V	5-115534
C214,215	Capacitor, 1.0 μ F, 16 V	5-115531
C216	Capacitor, 39 pF, 5%, 1 kV	5-118561
C217	Capacitor, 0.47 μ F, 10%, 100 V	6-111168
C300	Capacitor, 0.1 μ F, 10 V	5-113214
C302,303	Capacitor, 0.01 μ F, 2%, 100 V	6-113552
C306	Capacitor, 0.1 μ F, 20%, 50 V	6-110525
D100	Diode, Bridge Rectifier, MDA200	6-111240
D101	Diode, Silicon, 1N5059	5-113826
D102	Diode, Bi-Polar, ZNRSA8.5C	6-112697
D103, 104,		
D204, 205,		
D206, 209,		
D210, 212,		
D300, 301,		
D302, 303,		
D304, 305,		
D306	Diode, Silicon, 1N914	5-112004

Servicing Instructions

Symbol	Description	Number
D200, 201, D202, 203	Diode, Zener, 18 V, 1N4746A	5-117087
D207, 208,	Diode, Zener, 36 V, 1N4753A	6-112910
D211	Diode, Silicon, 1N4002	5-113201
IC100	IC, Dual Oper Amp, 7621	6-112219
IC101, 102, IC300	IC, Dual Oper Amp, TL062CP	6-110905
IC103, 301	IC, Triple 2 Channel MUX/DEMU, CD4053	6-112215
IC104	IC, Bargraph Interface, PP	6-113398
IC105	IC, Quad 2 Input NAND Gate, CD4093	6-112216
IC200, 304	Diode, Reference, 1.2 V, LM385Z	6-112221
IC201	IC, A/D Converter, 7106	6-113060
IC202, 203	IC, Oper Amp, 7611	6-112218
IC204	IC, TRMS Converter, AD636J	6-112214
IC302	IC, Diff 4 Channel MUX/DEMUX	6-113464
IC303	IC, Quad Oper Amp, TL064CP	6-113212
IC305	IC, Oper Amp, TL061CP	6-113008
MOV100, 101, MOV102, 103, MOV104	Resistor, Special MOV	6-110694
MOV300	Resistor, Special MOV	6-113210
Q100, 102, Q201, 203, Q204, 206, Q301	Transistor, NPN, 2N412	5-115931
Q101, 200, Q205, 300	Transistor, PNP, MPS3702	5-113864

Servicing Instructions

Symbol	Description	Number
Q202, 210, Q211	Transistor, FET, PN3687	6-112894
Q207, 208, Q209, 212, Q302	Transistor, FET, 2N4302	6-110059
R100	Resistor, 1 k Ω , 5%, 3 W	5-119931
R101	Resistor, Special, 2 k Ω , HVCL	6-112224
R102	Resistor, Special Attenuator	6-112780
R103	Resistor, 99.8 Ω , 1%, 1/4 W	6-112239
R104	Resistor, 900 Ω , 0.25%, 1/4 W	5-116273
R105	Resistor, 90 Ω , 0.25%, 1/4 W	5-116272
R106	Resistor, 9 Ω , 0.25%, 1/4 W	6-113535
R107	Resistor, Special, 0.1 & 0.9 Ω	6-111235
R108, 209	Resistor, 130 k Ω , 5%, 1/4 W	5-117709
R109, 201	Resistor, 330 k Ω , 5%, 1/4 W	5-116098
R110, 137	Resistor, 150 k Ω , 5%, 1/4 W	6-113474
R111, 133	Resistor, 240 k Ω , 5%, 1/4 W	6-111124
R112	Resistor, 110 k Ω , 5%, 1/4 W	6-113473
R113, 228	Potentiometer, 550 k Ω , Cermet	6-112245
R114, 119, R124, 128, R129, 134, R202, 215, R216, 217, R218, 220	Resistor, 100 k Ω , 5%, 1/4 W	5-118168
R115, 123, R125	Resistor, 100 k Ω , 1%, 1/4 W	5-116142
R116	Resistor, 24.9 k Ω , 1%, 1/4 W	6-113065
R117	Resistor, 1 k Ω , 1%, 1/4 W	5-115490

Servicing Instructions

Symbol	Description	Number
R118, 126, R132, 136, R210, 213, R214, 224	Resistor, 1 M Ω , 5%, 1/4 W	5-118305
R120	Resistor, 1.3 k Ω , 5%, 1/4 W	5-119636
R121	Potentiometer, 50 k Ω , Cermet	6-112161
R122	Resistor, 82 k Ω , 5%, 1/4 W	6-111155
R127, 226	Resistor, 10 M Ω , 5%, 1/4 W	5-116632
R130	Potentiometer, 100 k Ω , Cermet	6-111613
R131, 219, R227	Resistor, 22 k Ω , 5%, 1/4 W	5-118163
R135	Resistor, 1 M Ω , 1%, 1/4 W	5-117693
R138	Resistor, 6.2 k Ω , 5%, 1/4 W	5-117716
R200	Resistor, Special Fab, HVCL	3-812804
R203	Resistor, 15 k Ω , 5%, 1/4 W	5-113621
R204	Resistor, 221 k Ω , 1%, 1/4 W	5-117526
R205	Potentiometer, 5 k Ω , Cermet	6-112275
R206	Resistor, 16.9 k Ω , 1%, 1/4 W	6-112240
R207	Resistor, 182 k Ω , 1%, 1/4 W	6-113616
R208	Resistor, 470 k Ω , 5%, 1/4 W	5-118169
R211	Resistor, 200 k Ω , 5%, 1/4 W	6-110845
R212, 222	Potentiometer, 20 k Ω , Cermet	6-112244
R221	Resistor, 300 Ω , 5%, 1/4 W	5-119630
R223	Resistor, 10 k Ω , 5%, 1/4 W	5-118161
R225	Potentiometer, 500 Ω , Cermet	6-111611
R229	Resistor, 3.3 M Ω , 5%, 1/4 W	6-112250
R230	Resistor, 200 Ω , 1%, 1/4 W	5-119741
R300	Potentiometer, 100 k Ω , Cermet	6-113576
R301	Resistor, 24.9 k Ω , 1%, 1/8 W	6-113479

Servicing Instructions

Symbol	Description	Number
R302	Resistor, Special, 1 k Ω , , PIC	6-113123
R303, 326	Potentiometer, 500 Ω , Cermet	6-113467
R304	Resistor, 402 Ω , 1%, 1/8 W	6-113475
R305, 338	Resistor, 1 M Ω , 10%, 1/8 W	5-119421
R306	Resistor, 301 k Ω , 1%, 1/8 W	6-113482
R307	Potentiometer, 5 k Ω , Cermet	6-113469
R308	Resistor, 20 k Ω , 1%, 1/8 W	6-113481
R309, 310	Resistor, 10 k Ω , 0.1%, 1/4 W	6-113478
R311	Resistor, 6.81 k Ω , 1%, 1/8 W	6-113477
R312	Resistor, 806 Ω , 1%, 1/8 W	6-113476
R313	Resistor, 19.6 k Ω , 1%, 1/8 W	6-113480
R314	Resistor, 1 M Ω , 1%, 1/8 W	6-113483
R315, 325, R332, 333, R334, 335, R339	Resistor, 100 k Ω , 5%, 1/8 W	5-119433
R316, 319	Potentiometer, 500 k Ω , Cermet	6-113471
R318	Resistor, 200 k Ω , 1%, 1/8 W	6-113575
R324	Resistor, 324 k Ω , 1%, 1/8 W	6-113549
R327, 336	Resistor, 511 Ω , 1%, 1/8 W	6-113546
R328	Resistor, 220 k Ω , 5%, 1/3 W	6-113544
R329	Resistor, 470 k Ω , 5%, 1/8 W	5-119434
R331	Resistor, 680 k Ω , 5%, 1/3 W	6-113545
R337, 345	Resistor, 27 k Ω , 5%, 1/3 W	6-113543
R340	Resistor, 392 k Ω , 1%, 1/8 W	6-113550
R341	Resistor, 3.32 k Ω , 1%, 1/8 W	6-113547
R342	Potentiometer, 10 k Ω , Cermet	6-113527
R343	Resistor, 22.1 k Ω , 1%, 1/8 W	6-113548

Servicing Instructions

Symbol	Description	Number
R344, 346	Resistor, 47 k Ω , 5%, 1/8 W	5-119432
	Connector Receptacle, 34 Pin	6-111159
	Connector, Female Header, 12 Pin	6-113555
	Connector Assy., Input	10-865323
	Connector, Male Header, 4 Pin	6-113489
	Connector, Male Header, 12 Pin	6-113554
	Connector, Receptacle, 13 Pin	6-113490
	Socket, IC, 40 Pin	6-112228
	Switch, Function	6-113484
	Switch, Range	6-112230
	Board Assy., PC, Function	10-865256
	Board Assy., Range	10-865257
	Board Assy., dB/Osc.	10-865255
	Board Assy., PC, Display	10-865240
	Board Assy., PC, Peak Hold/dB	10-865254
	Button, Red	3-261157
	Button, Black	3-261158
	Button, Gray	3-261156
	Button, White	3-261155
	Cable, Assy., Oscillator	02061

NOTES



*Quality is the indispensable component
of every Simpson instrument*



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